Space Weather Technical Forecast

Issued on Saturday, 17 September 2022 at 01:13 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Now reduced chance of M-class flares. Slight Chance G1 into new UTC working week.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity was High over the past 24 hours, with a pair of M-class flares originating from AR3098 on the northwest limb. The first and largest of these was an M7.9 class flare, peaking at 16/0949 UTC; with the second a M6.2 at 16/1559UTC. Neither of these events appears to have spawned either a solar radiation storm or Coronal Mass Ejections (CMEs).

There were four numbered solar regions on the disc in the period, although the largest, most active and most complex of recent days, AR3098 became difficult to discern by the period's end, with only its trailing spot visible as a vestigial Hax/Alpha. The other residents of the disc were less active, with some trailer proliferation visible in AR3102 which was assessed as a Eao/Beta. Further west, proliferation was also observed in AR3103, but its overall complexity was capped at Bxi/Beta, while the final group was AR3100 - a slowly decaying Cso/Beta.

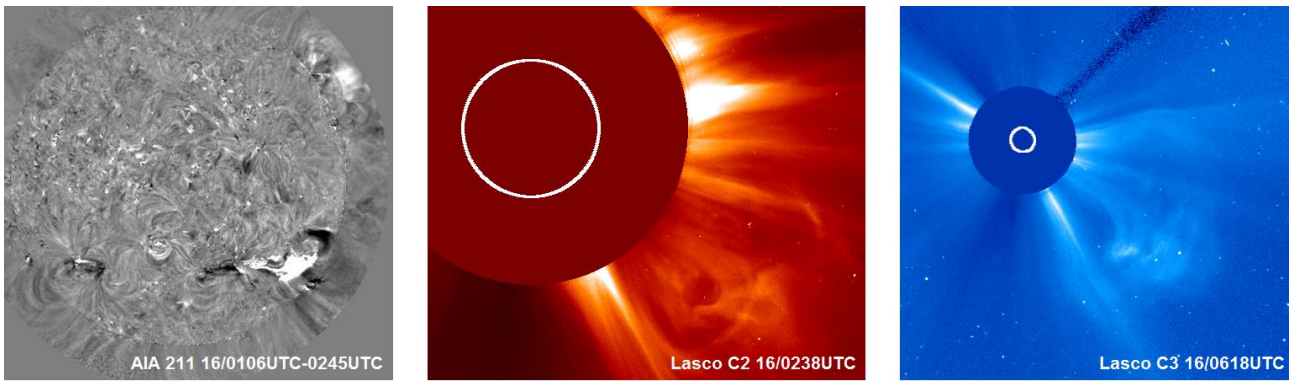

Figure 0: Three perspectives of the CME(s) from the southwestern quadrant in the period. A glancing blow is possible late in the UTC day of Sunday 18 September. Image processing for leftmost image courtesy of SIDC ROB.

Coronagraph imagery for the 24 hours was dominated by a pair of filament eruptions from the southwestern quadrant, starting around 15/2100UTC and 16/0100UTC. Of these, the latter was the more impulsive and violent, and as a result appears to have consumed the former in coronagraph imagery. These features have been analysed as a unified CME, with a possible glancing blow expected late in the UTC day of Sunday 18 September.

Solar Wind / Geomagnetic Activity: The solar wind, as measured by DSCOVR and ACE at L1, was characteristic of the tail end of CME influence ongoing since 14/2150UTC, segueing into a slow regime. The solar wind speed showed an erratic but very slightly increasing trend from 325km/s to occasional peaks near 375. The solar wind density was highest as the CME gave way to the slow regime, with peaks in the upper teens of ppcc briefly before falling to long term

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background in single figures ppcc to end the period. The IMF showed a reducing trend, from slightly elevated levels near 11nT to finish around 5nT. The north-south component of the magnetic field was greatest in magnitude with the tail of the CME's magnetic cloud at 9nT, with this failing to rotate into negative territory until the slow regime that followed, meaning only -3nT was reached in the other direction. The phi angle was mainly negative (towards the Sun), but with a more variable or positive period between 16/0400UTC and 1000UTC as the CME faded.

The net result of the above solar wind measures was universally Quiet Kp, provisionally peaking at just 2- in the 09-12UTC interval.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) as measured at GOES16, remained slightly elevated over the 24 hours, with a slightly rising trend to a peak of 3pfu that later moderated a little.

Electron flux was mainly at Normal Background levels, with diurnal peaks of the order of 250pfu starting and ending the 24 hours. The corresponding 24-hour electron fluence showed a flat trend near 1e7 integrated pfu, with an observed fluence value at 17/0001UTC of 8.64e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is expected to fall with the passing of AR3098, although for day one it probably remains near enough the front side to throw X-ray producing ejecta clear of the limb to give a peak Chance of M-class for the four days, otherwise being Slight. No notable regions are due over the eastern limb to counteract this fall.

Solar Wind / Geomagnetic Activity: There is one unified CME that features in the current forecast - the product of two filament eruptions starting 15/2100UTC and 16/0100UTC from the southwest quadrant. These may give a glancing blow late in the UTC of Sunday 18 September, and a corresponding Slight Chance of G1.

Coronal hole 23 (and/or 24) are overdue and correspondingly now expected to be more muted, perhaps greatest should it (they) arrive concurrently with the above CME - at the end of the current UTC weekend.

Initially Quiet conditions may rise to a Slight Chance of G1 late Sunday 18 and through Monday 19 September, returning to Quiet on Tuesday.

Energetic Particles / Solar Radiation: The chances of S1+ level solar radiation storms are slightly elevated given the already enhanced environment at GEO, although the trend is downwards as the most liable spot to produce such events rotates away from a favourable position in the period.

The high energy electron flux (greater than 2MeV) is expected to remain at mainly Normal Background levels until after the onset of any coronal hole high speed stream, probably now into the new working week UTC at the earliest. Because any driving feature is now expected to be more muted, any upward response in fluence is accordingly smaller, with a Chance of surpassing Active from Monday, probably peaking belatedly on Tuesday.

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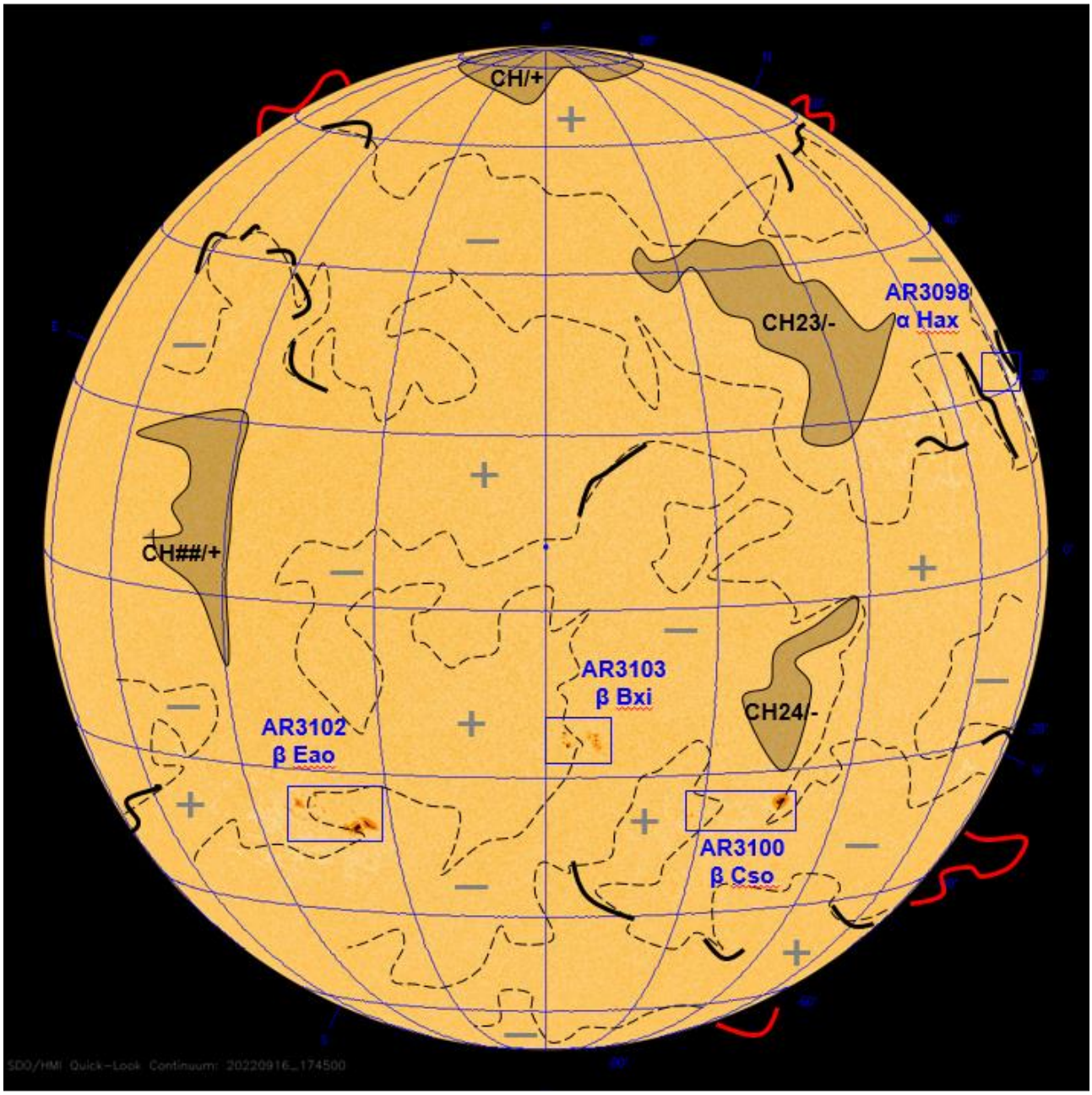
Figure 1. Solar Analysis Valid 16/1745UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

There is one unified CME that features in the current forecast - the product of two filament eruptions starting 15/2100UTC and 16/0100UTC from the southwest quadrant. These may give a glancing blow late in the UTC of Sunday 18 September, and a corresponding Slight Chance of G1. The MOSWOC Enlil ensemble solutions are relatively tightly clustered around the tail end of the UTC day of Sunday 18 September, although this is probably more a result of the 636km/s speed involved rather than a measure of precision.

The persistence forecast would otherwise have an incumbent high speed stream from coronal hole 23 or perhaps 24, however this is either very weak or has not yet occurred, and given its absence at STEREO A at the time of writing, its onset lies beyond 1.6 days' time. Its effects are correspondingly now expected to be more muted, perhaps greatest should it arrive concurrently with the above CME.

Initially Quiet conditions may rise to a Slight Chance of G1 late Sunday 18 and through Monday 19 September, returning to Quiet on Tuesday.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	1	20	20	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
16/0703	Partial	Filament eruptions	SW quadrant	636km/s	18/2100UTC	Lasco only, formed of two filament CMEs 15/2100Z and 16/0100UTC.

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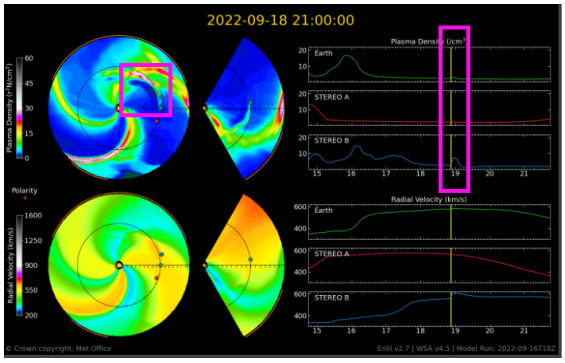
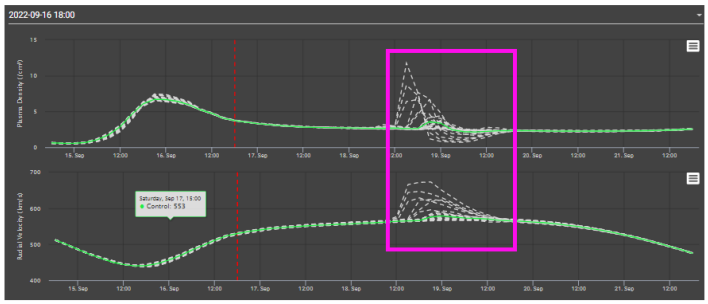
Figure 2: Latest MOSWOC Enlil run and ensemble, showing possible glancing blow from combined 15/2100 and 16/0100UTC filament eruptions from the southwestern quadrant. This assessment is of lower than average confidence as a result of a current not observed fast wind from CH23 and/or CH24 that is suggested by Enlil, and the fact that only Lasco could be used to fit the CME cone (no STEREO A data was available).





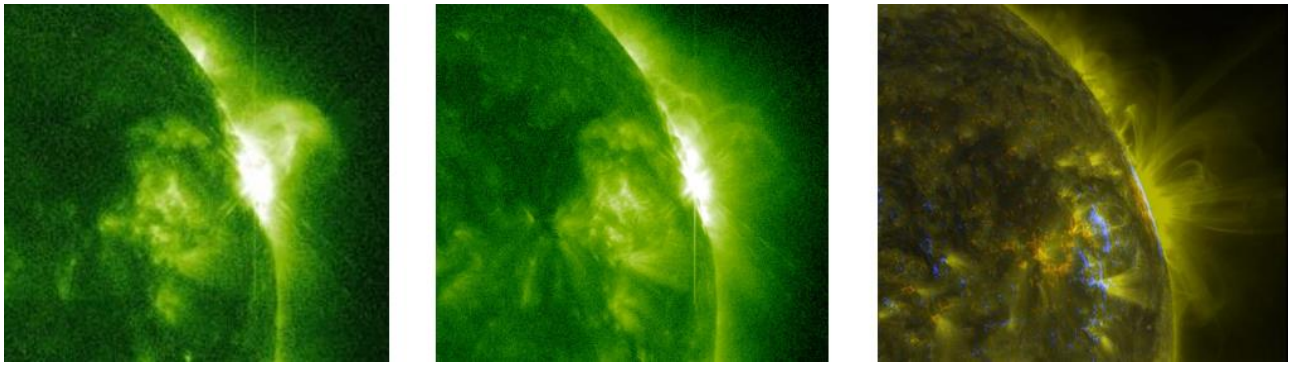
Radio Blackouts - X-Ray Flares:

There are currently four sunspot regions on the visible disc, however the surviving trailing spots of AR3098 are very shortly expected to cross the western limb to leave three simpler groups.

STEREO A EUVI 195 imagery does not currently hint at any major survivals in its visible eastern horizon, meaning that there are not expected to be any regions to counteract the expected fall in X-ray flare risk that comes with AR3098's departure.

X Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	R1-R2 M Class	Yes	30	20	20	20
Very Active	R3 to R5 X Class	No	5	1	1	1

Figure 3: AIA 094 images of the two M-class flares from AR3098 in the period: from left to right an M7.9 at 16/0949UTC, and an M6.2 at 16/1559UTC. Also shown is the spot in AIA171 and HMIBC as it appeared at 16/2319UTC.



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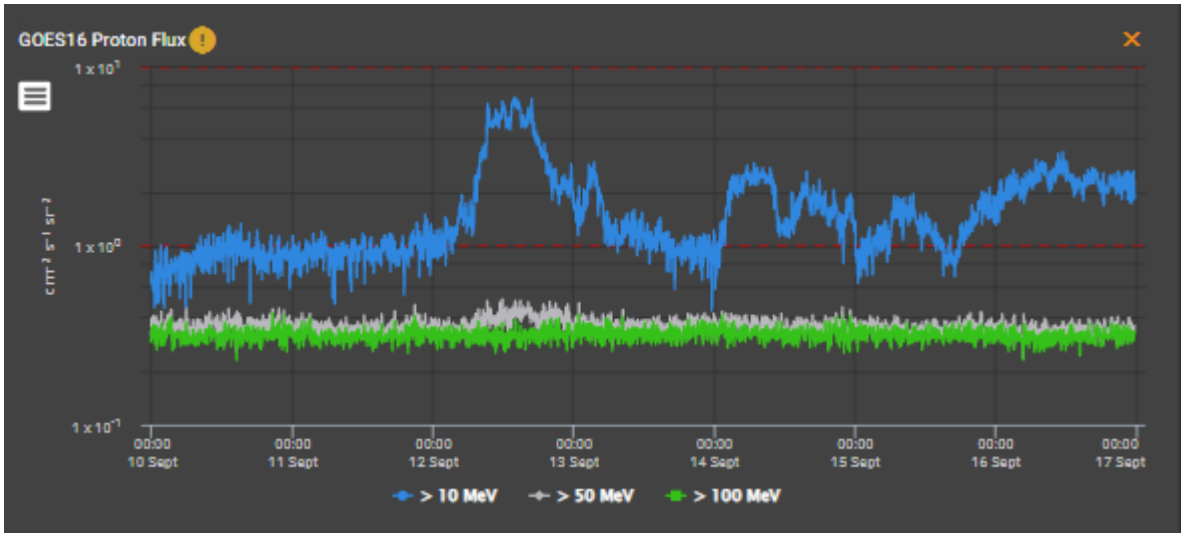
Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10MeV) remains slightly elevated, but sub-S1.

The cause of the current enhancement(s) is not certain, perhaps being related to unseen far-side activity (perhaps evidenced by the soft spectral rise), however the main sunspot region contributing to this risk (AR3098) should now progressively rotate away from a favourable position on the disc. There is a peak Slight Chance on day one, Saturday 17 September - in part also due to the higher baseline at present - however this should fall toward a nominal background over the course of the four days (barring far side activity maintaining counts at GEO).

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	15	10	5	5
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 4: Past week in high energy protons, with greater than 10MeV shown in blue. Most of these enhancements are thought to have been generated by far-sided activity.



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High Energy Electrons Event (≥ 2MeV):

The high energy electron flux (greater than 2MeV) is expected to continue its current very modest Normal Background to Moderate flux oscillation until after the advent of CH23/- and/or CH24/-. This had been due to arrive into the UTC weekend, however there is little evidence of any fast wind either at Earth or STEREO A, the latter being 1.6 days upwind. This is also despite similar orbital latitudes of Earth and the STEREO satellite relative to the solar equator. The reason for this is not clear - the phi angle is the correct negative at present, however unless the arrival was masked by the 14/2150UTC CME, this feature is expected to be both late and accordingly less impactful.

All considered, there is now judged a Chance of surpassing Active from Monday, probably peaking belatedly on Tuesday.

GEO Electron Environment	**Level (cm^{-2} sr^{-1} day^{-1})**	**Past 24 Hours (Yes/No)**	**Day 1 (00-24 UTC)**	**Day 2 (00-24 UTC)**	**Day 3 (00-24 UTC)**	**Day 4 (00-24 UTC)**
Probability (Exceedance)			**(%)**	**(%)**	**(%)**	**(%)**
Active	**≥ 2 MeV ≥ $1x10^{8}$**	No	1	5	25	30
Very Active	**≥ 2 MeV ≥ $1x10^{9}$**	No	1	1	1	1

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